Pilot study of diver exposure in contaminated water.
Health risks of members of Multnomah County Sheriff's Department diving in the Portland Harbor superfund site.

The purpose of this study was to consider assessing health risks of members of the Multnomah County Sheriff's Office who dive in the Portland Harbor Superfund site as part of their investigation and emergency activities. The study was initiated in 2001 in response to a request by the Multnomah County Sheriff's (LSO) Life Safety Office with concerns about the exposure levels of their River Patrol and Dive Team members due to diving in contaminated waters with inadequate dive suit protection. This risk assessment for the divers was never completed but the Dive Team was successful in obtaining new, safe appropriate diving suits.

The Sheriff's office provided Dr. Rothlein at CROET, OHSU with the individual log records (1998-2000) from five of their divers. The dive record included information on dive location, number of minutes submerged, depth of dive, water quality, degree of difficulty and description of protective equipment used for each dive. In 2001, the Sheriff's office reported that they had only 2 dry suits and more often the other suits leaked and the divers became either completely soaked or their neck and hands were exposed. The exposure pathways of greatest concern for the Sheriff's divers was direct dermal contact with sediment and river water and incidental ingestion. Incidental/accidental ingestion of river water could be primarily important when considering acute exposure to microbial contamination.

Each dive location was geocoded using GIS. The dive log reported dives in 39 different locations in the Columbia River, Columbia Slough and the Willamette River. The average duration of a dive was 21 minutes, with a minimums length of 4 minutes and a maximum length of 45 minutes per dive. The average total recorded minutes submerged per diver per year was 170 minutes. Six of the 39 dive locations recorded from 1998-2000 were in the initial study area (ISA) of the Portland Harbor site.

Average duration per single dive	21 min
Minimum duration per dive	4 min
Maximum duration per dive	45 min
Average total min/diver/single year	170 min
Average number of dives/year/diver	11
Max number of dives/year/diver	14

Dive Location	Lat	Long
Cathedral	45.485671	-122.761274
Cathedral Park (N}	45.586407	
Kelley Point (not ISA)	45.642433	-122.762652
Swan Is Basin USCG	45.469888	
Swan Island	45.562405	-122.771492
Wil Term 2	45.547953	
Wil-Term 1	45.540884	-122.722108

		-122.705378 -122.697111 -122.597688

Contaminant data were obtained from the SEDQUAL Database (2001) developed by the Washington State Department of Ecology. Initially, the database was used to obtain all sediment sampling results from 1990-1999 from stations within the Willamette and Columbia Rivers and the Columbia Slough and then data was selected within 1600 meters of all dive locations within the Portland Harbor site. Exposure estimates would be improved by repeating the analysis using the average concentrations (or 95% UCL) of those concentrations within 500 meters of a dive site. The number of dives at each location/year is used to adjust exposure time.

Name of Dive Site	# Samples	Min (ppm)	Max (ppm)	Mean (ppm)
Cathedral Park	4,640 (all compounds)			
Arsenic	128	0.70	10.02	4.09
Total PCBs	2*	0.59	0.59	0.59
Mercury	170	0.01	0.56	0.102
Benzo(a)pyrene	196	0.71	12,857	347.75
High MW PAH	66	0.38	138,000	11,105
Low MW PAH	28	0.48	387,000	14,841
Cathedral Park North	4,310 (all compounds)			
Arsenic	128	0.70	10.02	4.09
Total PCBs	2*	0.59	0.59	0.59
Mercury	168	0.01	0.56	0.101
Benzo(a)pyrene	182	0.71	12,857	368.07
High MW PAH	52	0.38	138,000	13,871
Low MW PAH	52	0.48	387,000	19,038
Kelley Point/Term 5	626 (all compounds)			
Arsenic	30	0.60	7.3	3.12
Total PCBs	2	6.41	6.41	6.41
Mercury	22	0.02	0.12	0.06
Benzo(a)pyrene	24	0.27	33.33	8.45
High MW PAH	22	3.54	296.29	68.28
Low MW PAH	22	1.40	66.67	12.65
Swan Island Basin (USCG)	7,940 (all compounds)			
Arsenic	330	0.60	640	10.93
Total PCBs	82	0.44	114.67	16.21
Mercury	46	0.02	1.51	0.15
Benzo(a)pyrene	326	0.35	256.16	9.45
High MW PAH	28	10.54	382.35	115.02
Low MW PAH	28	1.15	109.67	38.57
Swan Island	4,418 (all compounds)			
Arsenic	196	0.61	640	13.56
Total PCBs	64	0.71	114.69	16.87
Mercury	204	0.02	1.5	0.19
Benzo(a)pyrene	172	0.02	1.51	9.28
High MW PAH	10	0.35	256.16	16.51
Low MW PAH	8	1.33	8.88	4.45
Willameete-Terminal 2	1,516 (all compounds)			
Arsenic	88	1.4	6.0	3.25
Total PCBs	10	0.93	5.58	3.07
Mercury	70	0.05	1.06	0.14
Benzo(a)pyrene	58	0.03	45.82	5.72
High MW PAH	18	0.17	68.42	23.90

Low MW PAH	16	1.33	17.89	7.23
Willamette-Terminal 1	1,568 (all compounds)			
Arsenic	84	0.51	6.0	3.08
Total PCBs	12	0.93	710	120.87
Mercury	70	0.01	1.06	0.13
Benzo(a)pyrene	62	0.03	730	28.79
High MW PAH	32	0.17	7,400	491.71
Low MW PAH	30	0.66	960	74.90

- The PCB concentration of sediment samples collected on 9/26/1990 4 at Cathedral Park (2) and Cathedral Park North (2) were all reported at 51,788 ppm. These values were excluded in the above table 2. If included the mean value of total PCBs at Cathedral Park was 1,181 ppm.
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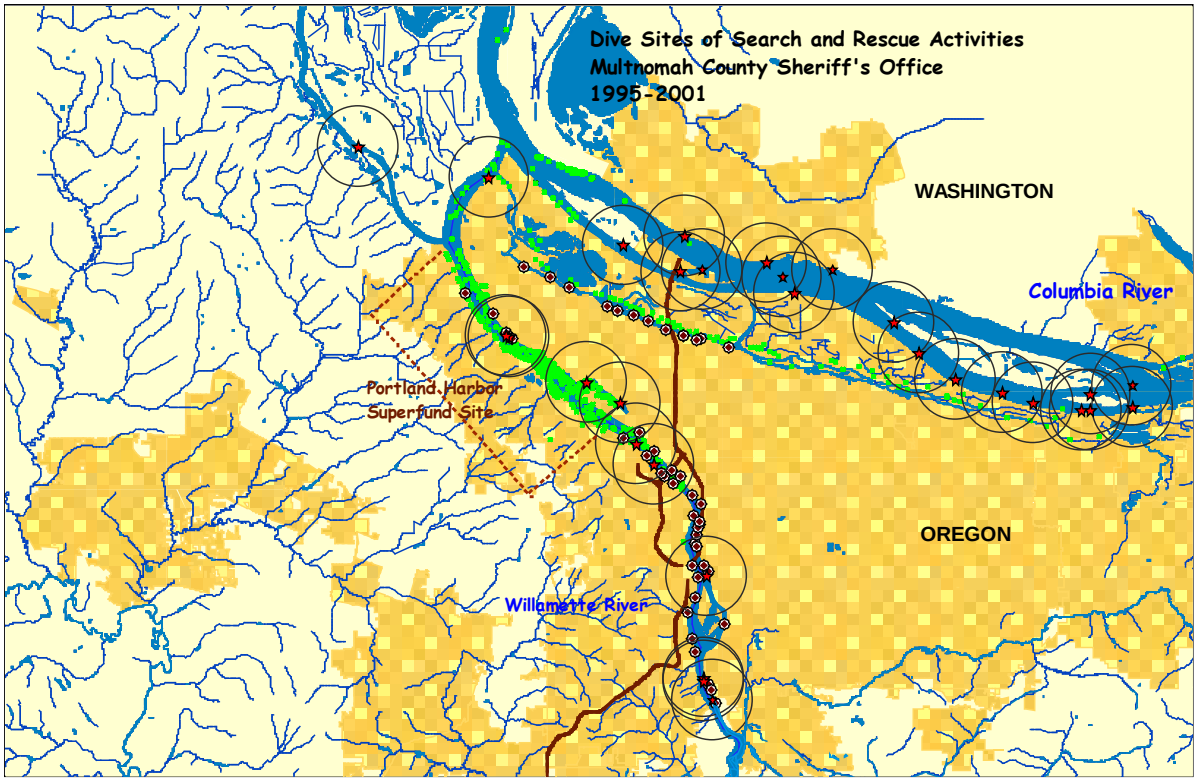
Table 2. Mean values (ppm) of sediment data reported in SEDQUAL database within 1600 meters of dive sites in Portland Harbor ISA.

Location	Arsenic	Total PCBs	Mercury	Benzo(a)pyrene	High MW PAHs	Low MW PAHs
Cathedral Park	4.08	0.59	0.102	347.75	11,105	14,841
Cathedral Park-N	4.09	6.41	0.101	368.07	13,871	19,038
Kelley Point	3.12		0.057	8.45	68.28	12.65
Swan Is Basin USCG	10.93	16.2	0.148	9.45	115.02	38.57
Swan Island	13.56	16.87	0.194	9.28	16.51	4.45
WillR Terminal 2	3.25	3.07	0.145	5.72	23.90	7.23
WillR-Terminal 1	3.08	120.87	0.134	28.79	491.71	74.90
Average	6.01	27.33	0.12	111.07	3,670	4,860



Red stars with buffer ring- Dive locations
Lime green dots- Sediment samples from SEDQUAL-2001

White circles- CSO Outfalls